LASERLAB-EUROPE

The Integrated Initiative of European Laser Research Infrastructures III

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Work package 4 – Scientific and Technological Exchanges

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Intermediate report on Scientific and Technological Exchanges

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Deliverable Nature	
R = Report, P = Prototype, D = Demonstrator, O = Other	R
Dissemination Level	
PU = Public PP = Restricted to other programme participants (incl. the Commission Services) RE = Restricted to a group specified by the consortium (incl. the Commission Services) CO = Confidential, only for members of the consortium (incl. the Commission Services)	PU

1 Introduction and objectives

Each member of the Laserlab-Europe Consortium possesses unique expertise in some domains of laser science and technology and infrastructure management. At the consortium level, the sum of this expertise is outstanding; at the individual level, the sharing of expertise benefits many members and increases the overall effectiveness of the Laserlab-Europe Consortium. The objective of this work package is to pool this distributed know-how and good practices concerning essential practical issues such as security, laboratory management and data acquisition procedures, as well as crucial scientific issues of relevance for many Laserlab-Europe participants. The outcome of this scientific and technological networking will be increasingly unified efforts from all members of the Consortium, pushing forward laser science and technology in the European Community at large.

2 Task 1: Technical workshops

Task leader: CNRS and the Laserlab-Europe Networking Board

Pooling of know-how is a very effective method to stimulate the overall expertise of the consortium. Technical workshops within the Laserlab-Europe Consortium have proved extremely beneficial in the past. Several issues are of general concern to many members of the Consortium. Examples include data acquisition procedures and standards, eye safety, radiation protection, simulation tools and interactive diagnostic techniques. The actors involved in this task furthermore aim at establishing and strengthening links to industry since many items pertaining to the Laserlab infrastructures are custom-made. Involving industry at an early stage will increase the afore-mentioned effectiveness. At least two technical workshops will be organized.

During the first months following the start of the project, a first internal call for proposals for technical workshops, to be primarily organized by Laserlab-Europe, was launched. This bottom-up approach should enable the consortium to select topics of highest relevance for the Laserlab partners and to ensure broad participation. Selection of a workshop was made by the Laserlab Networking Board. A second call for proposals for technical workshops, to be held during the second reporting period, was launched and evaluated.

First technical workshop: 23-24 September 2013, Laserlab Workshop "Characterisation of ultra-short high energy laser pulses", Abingdon, UK (CLF, M16)

A two day workshop was held in Abingdon, UK, on the characterisation of Ultra-short high-energy laser pulses and was attended by over 30 participants from 11 institutions. The workshop enabled the delegates to discuss the challenges surrounding the characterisation of laser pulses used in laser matter interactions. This is fundamental to the understanding and interpretation of the resulting data. The workshop was attended by delegates from established facilities and those that are developing their own systems. The sentiment throughout the presentations and discussions was one that enabled common problems to be aired and potential solutions identified. The format of the workshop was arranged so that the overall topic was divided into sessions, with a series of talks that were then used as discussion points for the rest of the session.

The first session concentrated on measuring the pulse durations of high energy Nd:Glass lasers, where the biggest problem is to ensure that there is a reliable pulse length measurement on a shot-to-shot basis. The discussion revolved around the issues of B-integral and its impact on the pulse shape and pulse length tuning and on pointing stability into the measuring devices. The methods used to attenuate the incident energy on the shot to reduce the B-integral for the diagnostics arms fell into two camps with the relative merits of reflective and transmissive schemes being discussed. In addition the technique of using a sub-aperture sample beam to measure the pulse length was also explored.

The second session was targeted at Ti:Sapphire laser systems with the higher repetition rate than Nd:Glass lasers. It was felt that the average pulse length measurement was appropriate for diagnosing the laser. With the shorter pulse lengths operated on these systems the pulse-front tilt is an additional problem and the talks in the session lead to discussions on the use of inverting interferometers for pulse front tilt measurements and the availability and reliability of commercially available diagnostics. There was a later session dedicated to different techniques for measuring the pulse front tilt, and this enabled a thorough discussion as to the limitations and advantages to the different schemes being developed by the speakers.

The third session discussed the difficulty associated with measuring the contrast of laser pulses. The talks from the session showed that whilst there are reliable schemes for determining the nanosecond contrast 'on the shot', the contrast within picoseconds of the arrival of the pulse still requires the use of a scanning device for stable measurement. It was also discussed that with the difficulty measuring pulse duration on the high-energy systems then measuring the contrast would be an even greater challenge.

Measurement of the spatial beam quality measurements on the shot was also an area that brought together a consensus that it was a difficult measurement to make; the best approach seemed to be an equivalent plane measurement or one that recreated a spot from a wave-front measurement.

With the advent of multi-PW laser systems the diagnostics challenges associated with these schemes lead to an interesting discussion on the relative merits of using parabolas for beam expansion for very broad bandwidths and how to maintain their alignment. Techniques for measuring and characterising damage to the final gratings were also discussed.

The problems associated with higher repetition rate laser systems lead to a discussion about automated processing of diagnostics and the potential problem with large amounts of laser diagnostic data and whether an average or sampling approach should be taken. Other highlights from this discussion included the use of reflective optical systems for polarisation control and the potential benefits of a dark-field imaging system for damage detection.

The delegates were then able to participate in a tour of some of the laser facilities operated by the CLF.

All presentations are available for download on the Laserlab webpage at

http://www.laserlab-europe.eu/networking/scientific-and-technological-exchanges/workshop-characterisation-2013-clf

3 Task 2: Collaborative Experimental Programs

Task leader: CEA-SLIC

The objective of this scientific and technological networking task is to increase the unified capacities of all members of the Consortium, pushing forward laser science and technology in the European community at large. To this end, this activity provides the general framework to help and encourage the organisation of intra-consortium staff exchanges, with two different lines of action:

3.1 Task 2a) Staff exchanges

Staff exchanges particularly focus on technical training and exchange of technical know-how and best practices, and address primarily technical staff. During the first reporting period, Laserlab has issued an internal call for applications from Laserlab scientists or technicians for staff exchanges. For the evaluation of the applications a Project Selection Panel, composed of representatives of the different Laserlab boards and one User Representative, was set up. Proposals were evaluated in view of the following criteria:

- Relevance of the objectives of the exchange and the needs of the sending institution;
- Appropriateness of the approach as well as of the host with respect to the objectives of the exchange;
- Qualification of the staff to be exchanged.

In each proposal the applicants explain how the proposed visit(s) will lead to important transfer of knowledge and/or good practice between partners of Laserlab-Europe. All five proposals received were found to be scientifically and/or technically interesting and well justified. The following intra-consortium staff exchanges were performed:

i) CLPU – CLF

Sending Institution: Centro de Laseres Pulsados Ultracortos Ultraintensos, Salamanca, Spain

Hosting Institution: Central Laser Facility, Rutherford Appleton Laboratory, STFC, UK

Duration: 4 weeks

Participating staff: Ricardo Torres, Luca Stockhausen

Objectives of the exchange: The objective of this exchange is to acquire hands-on experience on the implementation and operation of an experiment of proton acceleration in laser-plasma interactions. In particular we want to learn techniques for control of the pulse contrast, target alignment, plasma characterization, and proton detection. We intend to achieve these objectives by spending four weeks in the Central Laser Facility, at the time that Prof. Paul McKenna's team, from the University of Strathclyde, will be running an experimental campaign with the Gemini Laser. This exchange will also help to establish a collaboration between CLPU and the University of Strathclyde on laser ion acceleration.

The Pulsed Laser Centre (CLPU) is a new research facility established in 2007 with the purpose of building and operating a petawatt laser system (Vega) for national and international users.

The Vega laser will begin operations with 100 TW of peak power by late 2013. In its final phase it will be distinguished worldwide for its short pulse duration (30 fs) and high repetition rate at the petawatt level (1 Hz). As Vega will be the first ultrahigh intensity laser to become operative in Spain, it is expected to open new research lines in the country and bring new experimental opportunities to a community that had no previous access to this kind of science.

One of these lines of research is laser plasma acceleration and applications of laser-generated particle beams. The idea of CLPU is to generate secondary beams of protons, ions, electrons or X-rays, and make them available to the user community for research in materials science, inertial confinement fusion, or cancer therapy among many other applications.

However, the novelty of this technology in Spain also means that there is a lack of local expertise and know-how. The staff exchange programme of Laserlab thus becomes extremely important for us, and it is an ideal opportunity for CLPU to boost this strategic line of research in laser plasma acceleration and for the whole community to develop a technology with such potential impact.

Achievements: This staff-exchange programme has given us the chance to acquire hands-on experience in setting up and conducting an experiment of laser ion acceleration in a high-power laser facility. These experiments are extremely complex and the only way to get the right training on their operation is by attending an actual experiment being carried out by an experienced group. This is exactly the opportunity that has offered us the group of Paul

McKenna, of University of Strathclyde, in the Vulcan Target Area Petawatt of the Central Laser Facility - STFC.

We have been trained in the multitude of diagnostics that are used in laser-plasma experiments, their design, setting-up, operation and analysis. In particular we have got an in-depth training with Thomson parabola spectrometers, where we have practiced image plate processing and analysis of ion tracks. We have also learnt about the stacks of radiochromic films and how to design them using a software to calculate the stopping power of different materials. We have familiarised with the other diagnostics as well, including an electron spectrometer, a shadowgraph, a Mach-Zehnder interferometer, a Nomarski interferometer, optical spectrometers, and far field and near field imaging in back scattering and transmission.

Furthermore we closely followed the target alignment and change-over procedures in between shot cycles and have gained valuable knowledge about data acquisition and the local safety and radioprotection rules.

Overall this staff exchange provided us with an ideal training, because all this is very valuable and necessary for the development of the experimental capabilities of CLPU.

ii) CLPU – LOA

Sending Institution: Centro de Laseres Pulsados Ultracortos Ultraintensos, Salamanca, Spain

Hosting Institution: Laboratoire d'Optique Appliquée, Palaiseau, France

Duration: 4 weeks

Participating staff: Camilo Ruiz Méndez, Andreas Döpp

Objectives of the exchange: The aim of this staff exchange is to acquire technical skills and knowledge about experiments on PW class laser-driven electron acceleration. This visit aims for a detailed exchange of knowledge concerning different parts of the experiments, i.e. planning, setup, diagnostic, operation and analysis.

As CLPU's Multi Terrawatt Laser system Vega phase 2 is expected to be ready for experimental usage in late 2013, we are currently in the planing phase for the setup of first experiments on laser wakefield acceleration (LWFA). Within Laserlab-Europe LOA is one of the institutions with the longest tradition and this is why it will be highly advantageous for the scientist at CLPU to spend some time there to learn from them about technical details, both on the setup itself as about the diagnostics. Beside their long experience in LWFA, the new Salle Jaune laser system is a double beam system, which allows to perform experimental configurations similar to the phases 2 and 3 in Vega, currently in construction at the CLPU site. In this phase of the project an intense exchange is crucial in order to provide the best design of the Vega target area and experimental setup, all efforts to improve the setup for underdense targets in Vega will impact in the scientific output of this user facility.

Achievements: The staff exchange activities took place in two visits, the first one in June 2013 to learn on the techniques of detection of X-rays and to participate in an experiment of Compton Scattering at Salle Jaune in LOA. The technique developed at LOA (K Ta Phuoc, Nature Photonics 2012) has shown to be the easiest to implement and very robust allowing the production of a bright X-rays pulses with energies in the range of 100 KeV.

The second visit took place in November/December 2013, to perform a series of simulations of our next experiments. During these three weeks Camilo Ruiz Méndez has been working with Dr. Kim Ta Phuoc and Dr. Agustin Lifschitz using the PIC code CALDER to simulate the collision of two high power laser pulses. The simulations aim to provide a parameter range for the experiment that will be performed later this year at LOA. The objective is to inhibit the plasma wake to increment the oscillation of the electron in the bubble and enhance the betatron radiation produced. The results have been satisfactory and these parameters will be used to perform the experiments.

The exchange has proven to be a very valuable tool to implement the collaboration and to finally exchange knowledge from an institution with long experience to a young institute as CLPU. The collaboration between LOA and CLPU will continue over time and the scientific result from the collaboration will be of great value for both institutions. The exchange produced in these visits has allowed a deep insight into the things CLPU has to put in place to make our installation successful.

iii) IST – CLF

Sending Institution: Instituto Superior Técnico, Group for Lasers and Plasmas, Lisbon, Portugal

Hosting Institution: Central Laser Facility, Rutherford Appleton Laboratory, STFC, UK

Duration: 2 weeks

Participating staff: Gonçalo Figueira

Objectives of the exchange: To acquire practical know-how in the following areas:

- daily set-up and operation of an ultra-high power laser (Vulcan PW)
- related pulse and beam diagnostics, large aperture beam alignment
- shot data management and storage

IST operates a 20 TW Ti:sapphire / Nd:glass laser system, which has considerable internal demand. Currently, a new, larger facility is being designed, which will host an upgraded version of this laser system and multiple target areas. The upgrade will consist in the addition of an existing 64 mm rod amplifier, capable of increasing the power beyond the 50 TW level, a larger vacuum compressor chamber and gratings, and a new target area.

This upgrade will be the most significant change to the configuration of the laser chain of the last years, and it must be accompanied by a number of improvements at the level of reliability, control, and beam and pulse diagnostics. The overall objective is to maximize the number of successful shots, develop an integrated and reliable suite of diagnostics, and implement tested and successful mechanisms for managing and storing the shot data. It is expected that these measures will allow a faster experimental turnover and a streamlined, more successful use of the facility at IST.

The Vulcan PW laser at the CLF is a world-leading, state-of-the-art facility, operating at the same wavelength (1053 nm) and a similar pulse length (~500 fs) as the system in Lisbon. This is especially important since the practical know-how for spectrum and pulse diagnostics can be easily shared, and a fruitful interaction can be easily built on that common expertise.

Achievements: The exchange took place during a period of maintenance of the Vulcan PW laser system. This was chosen specifically to allow full access to all the stages of the laser system. I joined the Vulcan Laser Team and had the opportunity to interact with several members in a number of the maintenance activities. Below is a summary of the highlights of the exchange period.

- Vulcan laser operation

I learned about the daily procedures for starting, aligning and optimizing the laser system, and compared with my own experience on these aspects. I discussed the application of the alignment tools used, from iris diaphragms to movable crosshairs and compact CCD/CMOS cameras.

I discussed issues such as the stability of the laser system over daily operation, thermal management and vibration, or the influence of air-conditioning in the stability of the high power shots. I followed the full procedure for a high power shot, from interaction with the users, setting up the desired parameters, safety precautions before a shot, and recording and analysis of the results.

I also had the opportunity to learn about recent developments in the crystal testing facility of relevance to future OPCPA upgrades in Vulcan.

- Short pulse diagnostics

I was introduced to the different types of autocorrelators being used for the Vulcan PW laser. I discussed the pros and cons of each type. In particular, I discussed a recent model of autocorrelator with a very large temporal window, which has proved very successful for measuring pulses 100's of fs long. I had the opportunity to visit and evaluate the TAP diagnostics, in particular the recent ones for a low B-integral, sub-aperture beamline, sampling a small fraction of the large PW beam from a small hole in one of the final mirrors before the target. I evaluated some recorded shots and compared the measurements given by an autocorrelator and a GRENOUILLE diagnostic. I analyzed and discussed features present in the temporal measurements, and tried to correlate those with known nonlinear effects and uncompensated dispersion.

- Shot data management and storage

I learned about the type of data acquired for each shot and the several software options tested over the years. I discussed several hardware issued related to using a large number of diagnostics. I also compared the treatment of autocorrelation results with my own practice.

- Workshop 'Characterisation of ultra-short high energy laser pulses'

This Laserlab-Europe workshop took place during the period of my stay. The workshop was very interesting, with a lively exchange of ideas and know-how for characterizing short laser pulses. This gave me additional opportunities to learn about techniques and best practices used at other facilities.

Overall this was an extraordinary opportunity for exchanging practical know-how in high power laser operation, which provided me with a renewed insight into many aspects of my own laser facility.

iv) IST – ICFO

Sending Institution: Instituto Superior Técnico, Group for Lasers and Plasmas, Lisbon, Portugal

Hosting Institution: The Institute of Photonic Sciences, Barcelona, Spain

Duration: 2 weeks

Participating staff: Hugo Pires

Objectives of the exchange: To acquire practical know-how in the following areas:

- design and operation of a mid-infrared (MIR) OPA laser chain

- daily set-up and operation of a MIR laser

- specifications and diagnostics for ultra-broadband pulse compression at the MIR range

The laser R&D team at IST is currently assembling an OPCPA chain based in the nonlinear crystal YCOB, pumped by the frequency doubled output of a multipass Yb:YAG amplifier (100 mJ, 1030 nm, 1 Hz), and seeded by a supercontinuum spectrum. The expected output parameters of this ultrashort pulse chain are 20 mJ / 20 fs / 1 Hz, with a bandwidth extending from 700-900 nm.

The idler of the OPCPA stages is a broadband pulse in the mid-infrared extending from 1.2 – 2.0 µm. This spectral range has recently attracted much attention because of its favourable properties for the study of phenomena such as high order harmonic generation or ultrafast spectroscopy. However the IST group has no previous practical experience working in this wavelength range. Although it is feasible to implement a new ultrashort source derived from compressing the idler of the OPCPA system, it would be much more efficient to acquire previous know-how about the optics, diagnostics, etc from a group with recognized experience.

The Attosecond and Ultrafast Optics group at ICFO has recognized expertise in the development of high-average-power, CEP-stable, few-cycle sources in the mid-infrared, making it an excellent partner for the purposes of this staff exchange.

Achievements: The exchange took place during a period of maintenance of one of the laser chains of the ICFO-Atto laser system. This was chosen specifically to allow full access to all the stages of the laser system. I joined the Laser Team and had the opportunity to interact with several members in a number of the short maintenance, development and characterization activities. Below is a summary of the highlights of the exchange period.

- mid-IR compression and diagnosis

I learned about the suitable materials and techniques for aligning, compressing and characterizing a laser system operating beyond the 1.2 microns, and compared with my own experience on these aspects. I discussed the available options for prism pairs, spectrometers and screen cards. I built a gratings compressor and tested the compressibility of a 1.5 micron beam, also measuring its astigmatism.

- Electronic beam synchronization

I was introduced to the aspect of electronically synchronizing a laser chain with its pump system, learned on the implications and saw first-hand the consequences of such a system. I had the opportunity to learn the physical and the computer implementations of the synchronization system, and was tasked to try to integrate the system to a more compact and autonomous performance.

- OPCPA optimization in periodically poled crystals

I learned about the type non linear crystals used to amplify laser pulses at ICFO. I discussed several considerations on the usage of such crystals and performed a bandwidth and efficiency study for some crystals that had yet to be studied.

- Novel laser chain modeling

During my stay I was tasked with assisting the modeling for a mid-IR system and performed simulation leading to the calculation of the sizes for the crystals to be bought to create the system as well as the expected outputs at each OPCPA stage of the chain.

Overall this was an extraordinary opportunity for exchanging practical know-how in high power laser operation, which provided me with great knowledge and awareness of the main difficulties of developing and working with mid-IR laser system, which will help greatly in many aspects of my work in my own laser facility.

3.2 Task 2b) Joint Experiments

Joint Experiments are jointly proposed and conducted by scientists from one or more partners involved in the Laserlab-Europe Transnational Access Programme. The objective is to reinforce the scientific collaboration between these Laserlab-Europe partners and to gather their expertise in order to carry out very ambitious research studies at the forefront of their scientific domain. If necessary, the experiment may also be carried out at several laboratories with complementary contributions. Applications for Joint Experiments are subject to scientific evaluation by an external Selection Panel with excellence as the main criterion. The infrastructure hosting a Joint Experiment will provide free access to its installation without charging any User Fee. Proposals for such experiments are possible at any time.

Seven proposals for “Joint experiments” were received during the reporting period and evaluated by the Access Selection Panel. The following five “Joint experiments” were performed:

i) CNRS/CEA – LLC

Sending Institution: Laboratoire pour l’Utilisation des Lasers Intenses, CNRS, Palaiseau, France, and CEA-Saclay - SPAM, Saclay, France

Hosting Institution: Lund Laser Centre, Lunds Universitet, Lund, Sweden

Duration: 10 days

Participating staff: Brigitte Cros, Frédéric Desforges, Sandrine Dobosz Dufrénoy, Jinchuan Ju

Objectives of the exchange: The main objective of this project is to measure in detail the characteristics of electron bunches and the associated X-ray betatron radiation produced in long plasmas, to achieve a better understanding of the mechanisms which control the X-ray spectrum. The use of capillary tubes as waveguides allows to generate electron bunches in a large range of plasma densities and lengths and the effect of these parameters will be studied. The spectra of accelerated electrons and of the X-ray radiation produced by betatron oscillations will be measured. A spherically bent crystal spectrometer will be used to measure X-ray spectra in the 1-10 keV range and image the X-ray distribution. As the X-ray and electron bunch parameters are closely linked a better description of both electron acceleration and X-ray emission will be obtained through the comparison with PIC simulations.

Achievements: The experimental campaign worked very well. Active stabilization of the laser pointing was used and laser parameters were recorded on each shot Thanks to the high laser beam pointing stability of the Lund TW laser long data series of laser wakefield acceleration in gas filled dielectric capillaries could be recorded, and the stability of the electron beams investigated. These beams were found to be more stable in charge and pointing than the corresponding beams of electrons accelerated in a gas jet. Electron beams with an average charge of 43 pC and a standard deviation of 14% were generated. The fluctuations in charge were found to be partly correlated to fluctuations in laser pulse energy. Gas density fluctuations, between different laser shots, were suspected to be a more important source of instability. The pointing scatter of the electron beams were measured to be as low as 0.8 mrad (rms).

ii) ILC – LENS

Sending Institution: International Laser Centre, Bratislava, Slovakia

Hosting Institution: Laboratorio Europeo di Spettroscopie Non Lineari, Sesto Fiorentino (Florence), Italy

Duration: 3 days

Participating staff: Dusan Chorvat, Martin Uherek

Objectives of the exchange: The project has ambition to contribute to understanding of the mechanisms of changes in collagen reorganization in aorta wall accompanying development of cardiovascular diseases, using nonlinear microscopy imaging - in particular second harmonic generation (SHG). The organization of collagen fibers studied by SHG imaging has the potential of being used as a probe for determining the risk factor associated with a cardiovascular disease, and will significantly enhance results obtained by our group so far using standard microscopy techniques.

Main objectives of the proposed research are:

1. Measurement of spatially and spectrally resolved signal from collagen in rat aorta using pulsed femtosecond laser excitation,

2. Research of the potential of simultaneous SHG and autofluorescence / FLIM (fluorescence lifetime) imaging of unstained aorta for diagnostics of cardiovascular diseases,

3. Investigation of structural (re)organization of collagen in rat aorta by computational analysis of SHG images.

Achievements: In this study we investigated rat aorta samples (fixed in formaldehyde) from three different animals using second harmonic generation (SHG) and fluorescence imaging. We proved feasibility of quasi-simultaneous measurement of the spatial distribution of collagen related to SHG signal, and NADH and flavin molecules manifested by cellular autofluorescence. The data gathered within this study significantly advanced our understanding of the mechanisms of changes in collagen organization in aorta wall, accompanying development of cardiovascular diseases. The visit also allowed us to gain knowledge leading us to successful implementation of a new imaging modality (forward SHG) in the Laboratory of laser microscopy at ILC, Bratislava within the frames of JRA Bioptichal.

Using the advanced setup for nonlinear microscopy imaging at LENS we were able to image structural details of three different samples of aortas i) from control animals - Wistar rats, ii) rats fed with cholesterol-rich diet, and iii) rats with diabetes induced by streptozotocin. We imaged the rat aorta wall by second harmonic (SHG) imaging using 840nm excitation by Ti:Sa femtosecond laser (Chameleon, Coherent, USA). SHG images from all samples were acquired as a 3D data stack at three different locations of aorta, using two different objectives (20x / 40x). Overall, 18 (3x6) three-dimensional datasets were acquired, in addition to several high-resolution 2D images. In comparison to the preliminary data obtained previously at ILC using ytterbium 1038nm laser, the images gathered during the PCS stay show higher contrast and resolution, as well as better deep-tissue transmission. For control samples we used also the fluorescence detector and setup for time-correlated single photon counting to image spatial distribution of autofluorescence and autofluorescence lifetimes in NADH and flavin regions (excited by 740nm and 840nm, respectively). The experimental data were numerically and statistically analyzed to characterize spatial frequencies in different sample types, allowing to more precisely quantify the collagen fiber arrangement.

The results of the study were presented at Laser Physics Workshop, July 2012, Calgary in the form of a lecture "High-resolution second-harmonic generation imaging of rat aorta" and at Mikroskopie 2013 - annual conference of Czecho-Slovak Microscopy Society, Lednice, Czech Republic as a poster presentation: "Advanced optical imaging of aorta".

iii) LOA – GSI

Sending Institution: Laboratoire d’Optique Appliquée, Palaiseau, France

Hosting Institution: Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Duration: 8 days

Participating staff: Eduardo Oliva, Philippe Zeitoun, Lu Li

Objectives of the exchange: The goal of this experiment is to measure the energy extracted when seeding plasma based amplifiers of soft X-ray radiation. A more-than-linear increase of energy with plasma width has been proposed from hydrodynamic simulations, explained with the role of 2D hydrodynamical effects. Since these optimal amplifiers (short and wide) are on the opposite point of state of the art amplifiers (long and narrow) it is necessary to study experimentally this correlation. In this experiment we plan to measure the output energy of different sized amplifiers, seeded with another smaller plasma to overcome self-emission.

The total output energy will be measured to study the correlation between plasma width and extracted energy.

Achievements: An improvement of the brilliance of the Ni-like Mo X-Ray laser by nearly two orders of magnitude was achieved.

iv) LOA – MBI

Sending Institution: Laboratoire d'Optique Appliquée, Palaiseau, France

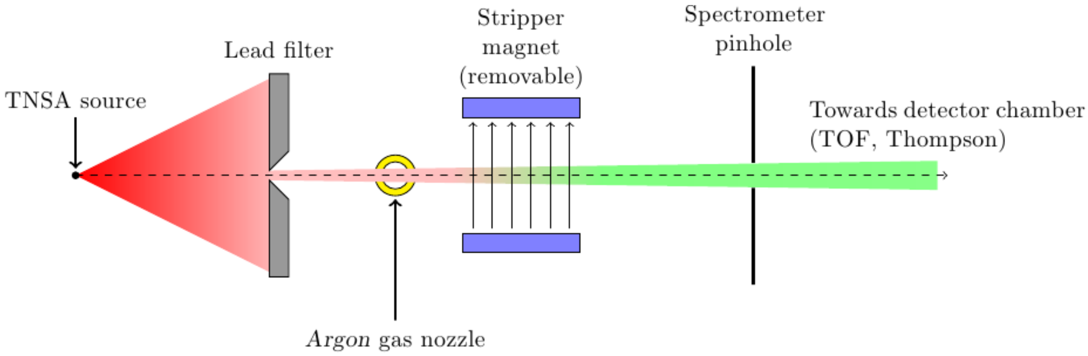
Hosting Institution: Max Born Institute for Nonlinear Optics and Short-Pulse Spectroscopy, Berlin, Germany

Duration: 4 weeks

Participating staff: Victor Malka, Alessandro Flacco, Florian Mollica, Benjamin Vauzour, Giulia Folpini, Gabriele Birindelli, Luca Antonelli

Objectives of the exchange: The creation of neutral or negatively charged atoms in laser-solid foil ion acceleration setup has been sometimes observed, although no completely explored yet. In this project the creation of such charge states were studied by a controlled preplasma or by having accelerated particles propagated through a gas jet.

Primary objective: create exotic charge states (negative, loosely bound) among the laser accelerated ions, by changing the preplasma conditions on the illuminated surface of the solid target (as observed in previous experiments in LOA).



Secondary objective: produce and characterize a beam of accelerated neutral atoms by neutralising the laser accelerated positive charge in an Argon gas jet.

The diagnostic devices put in place are also expected to produce additional informations on the neutral component that is present among TNSA accelerated particles in normal conditions.

Achievements: Primary objective: it hasn't been possible to observe the searched interaction condition, possibly for non sufficient control on the creation of a pre-heating beam, on its energy, on the synchronization and on the spatial superposition with the pump beam.
Secondary objective: it has been possible to produce and characterize a stable beam of neutral carbon atoms, with a maximum energy of 3.6MeV (300 keV/nucleon). Different diagnostics have been installed to ensure the typology of observed particles and to be able to quantitatively compare the neutralized with the non-neutralized signal.

The use of a removable stripper magnet in conjunction with a Time-of-Flight detector and a Thompson Parabola also permitted to conclude that no neutral atoms are accelerated in normal TNSA interaction conditions.

The performed activity permitted to open many issues, from the experimental and from the theoretical points of view, which will certainly be addressed in experimental campaigns to come *v) ICFO – CUSBO*

Sending Institution: The Institute of Photonic Sciences, Barcelona, Spain

Hosting Institution: Centre for Ultrafast Science and Biomedical Optics, Politecnico di Milano, Dipartimento di Fisica, Milan, Italy

Duration: 10 days

Participating staff: Simon Wall, Timothy Miller

Objectives of the exchange: We propose to investigate and control ultrafast demagnetization processes in the antiferromagnetic insulating compound Cr_2O_3. Due to the stronger exchange interaction between spins in antiferromagnetic systems, the spin orientation can be manipulated on significantly faster timescales than those found in ferromagnets, making them attractive materials for future devices. We will investigate how the spin system in Cr2O3 can be controlled by ultrafast pulses of light, focusing on comparing the efficiency of the demagnetisation process when the sample is excited by above-gap excitation, leading to a reduction in magnetisation through electron-spin scattering, to that from resonant excitation of magnons, where the spin order is directly perturbed. The system will be probed by both second harmonic generation, which is a direct probe of the magnetic ordering in the system, and sum frequency generation spectroscopy, which is sensitive to the different components that give rise to the magnetic order. This will allow us to separate the relative contributions of the crystal field and spin-spin interactions to the demagnetization process and will provides significant new insights into the processes that govern melting dynamics in antiferromagnetic compounds.

Achievements: The pump-probe measurements performed in Polimi ultrafast spectroscopy lab aim to a better understanding of the demagnetization process in the antiferromagnetic insulator Cr_2O_3. This compound orders antiferromagnetically at room temperature TN=305 K and it displays a gap of 2 eV. The transition from paramagnetic to antiferromagnetic order is accompanied by a change in the crystal structure from centrosymmetric to non-centrosymmetric. This change of structural properties gives rise to a finite second order susceptibility and makes the sample capable to emit second harmonic (SH) signal. Therefore SH generation is a direct probe of the antiferromagnetic order in Cr_2O_3. In order to study how the antiferromagnetic order can be quenched by an ultrashort laser pulse, the sample has been excited in two different ways: by pumping with photon energies above the band gap (Epump=2.4 eV), where the demagnetisation could be destroyed by injecting hot carriers through electron magnon-scattering and below the gap (Epump=1.7 eV) by directly exciting the exciton magnons.

The measured SH transient response displays a markedly different behavior in the two excitation condition, showing that the physical mechanism involved has different origin. In case of above gap pumping, the demagnetization process is characterized by a finite build-up signal (~250 fs) which is followed by a fast decay (of the order of 100 fs) and an extremely slow plateau. For below gap excitation, the build-up signal is within the temporal resolution of the experiment (~150 fs) while the fast dynamics is completely absent. Further additional measurements are required to clarify the physical origin of the antiferromagnetic melting process and will be performed in the near future. In particular the dependence of the SH transient signal by slightly varying the pump energy across the gap will be studied together with the transient reflectivity.

4 Task 3: Thematic Networks

Regular scientific and technological exchange is crucial, but it is especially fertile on the two following frontiers of laser science: high-energy laser systems, and ultra-high intensity ultrashort-pulse laser systems. Each of these areas fits into a pan-European large-scale project: HiPER and ELI, respectively. Those projects will benefit greatly from these networking activities which aim at stimulating all possible exchanges related specifically to such high-performance lasers, and which will strengthen the link between Laserlab-Europe and the respective consortia. The Task 3 participants will organise two research and technology networks within Laserlab-Europe. These networks are by nature open to all Consortium participants.

4.1 Task 3a) Networking Activity on Ultra-High Intensity Ultrashort Lasers (NAUUL)

Task leader: CLPU

Ultrashort-pulsed petawatt technology constitutes one of the main frontiers for laser infrastructures. In fact, only a few ultrashort pulse petawatt lasers are operating worldwide, and a large fraction of these within Laserlab-Europe. Moreover, some other European countries, such as Spain and Romania, have decided to invest into such technology. The aim is to increase concerted actions between the new ultra-high intensity programmes in Spain and Romania and the existing programmes in France, UK and Germany. Imperative will be knowledge sharing on topics such as large diffraction gratings, vacuum compressors and radio protection. This shall be implemented through a forum, which will ultimately help to increase efficiency, resource cost and aid in optimizing national resources. Such a forum for networking on ultra-high intensity, ultra-short lasers (NAUUL) will be implemented through annual meetings of participants. These meetings will take place at an existing or upcoming facility in order to be able to discuss issues and solution on-site. Reports will be prepared which summarize the meeting’s outcome and will be disseminated to all Laserlab-Europe partners.

The Networking Activity of Ultrashort Ultraintense Lasers is building on the network established under Laserlab-Europe II and continues to monitor closely the progress made in new high-power laser facilities, intense laser technology, and related topics. NAUUL promotes personal contacts through small meetings, that is, one or two-days round-table working sessions on some specific topic with a limited number of participants. In order to do that, a call for topics was made through the forum of NAUUL on the website of Laserlab.

The first of such meetings took place in June 2013 near Jena (Germany) and addressed the most pressing issues concerning the day-to-day operation of high-intensity lasers, i.e. pulse characterisation and control, targetry, detection of secondary radiation, etc. The second proposed meeting will take place in Abingdon (UK) in April 2014 and it will be devoted to examine the effect of target, laser and diagnostic developments of relevance for solid target interactions. This topic is very important for inertial confinement fusion and ion acceleration research, and it is becoming critical as the power and repetition rate of currently available lasers is increasing.

2013 annual network meeting: 'Operation of PW laser facilities', 13-14 June 2013, Jena, Germany

(Organisers: Philippe Martin, Ricardo Torres, Gerhard Paulus)

The first annual meeting of the Networking Activity of Ultra-intense Ultrashort Lasers (NAUUL) was held at the Dornburg Castles, near Jena (Germany), the 13th and 14th of June 2013. It was co-organized by Prof. Gerhard Paulus (Helmholtz Institute – Jena, Germany), Prof. Philippe Martin (CEA – Saclay, France), and Dr. Ricardo Torres (CLPU – Salamanca, Spain). The meeting was made to coincide with the 2nd Workshop on Operation of PW-class Lasers, the first of which took place in 2012 in Paris.

The workshop was devoted to PW-class lasers and addressed the most pressing issues concerning the day-to-day operation of high-intensity lasers, including topics like pulse characterisation and control, targetry, detection of secondary radiation, etc. It attracted some of the most recognised experts from Europe on each topic. One of these problems is how to measure accurately the properties of the laser pulses at such high powers. In particular, some novel methods for measuring ultra-high intensities were proposed, based on the momentum distribution of laser-produced ions (Gerhard Paulus), laser-induced Zeeman effect (Evgeny Stambulchik – Weizmann Institute of Science, Israel), and non-linear Thomson scattering (Antonino Di Piazza – Max Planck Institute for Nuclear Physics, Heidelberg, Germany). The enhancement of the pulse contrast and its measurement is another important issue, which becomes more critical as the intensities get higher. Also critical is the current impossibility to measure the pulse contrast in a single shot. Methods to reduce the pre/post-pulses and the experience with the Polaris laser in Jena (Malte Kaluza – Helmholtz Institute – Jena, Germany) and the Vulcan laser in the UK (Alexis Boyle – CLF-RAL, UK) were presented.

Apart from the issues concerning the lasers themselves, the utilization of these systems in the laboratory poses many technical difficulties. The protection of the electronic equipment against the electromagnetic pulse generated by the laser shot was addressed by Eyal Kroupp (Weizmann Institute of Science, Israel). The production of microtargets for laser-plasma interaction is becoming very challenging due to the ever more sophisticated target designs demanded by the experimenters, and the need to deliver targets at the high repetition rates of current state-of-the-art high-intensity lasers. The most advanced techniques for target fabrication and characterization were presented by Chris Spindloe (CLF-RAL, UK). The increasing repetition rate of forthcoming laser systems also pose a challenge to the detectors of the particles originated in the laser-target interaction. Josefine Metzkes (Helmholtz-Zentrum Dresden-Rossendorf, Germany) showed her achievements in the development of online proton detectors based on scintillators.

Finally, representatives from ELI-ALPS (Mikhail Kalashnikov) and ELI-NP (Traian Dascalu) presented an update of the progress on both projects, and the commercial companies Amplitude Technologies (Gilles Riboulet) and Thales Optronique (Denis Levaillant) provided the manufacturers' point of view into the problems of operating PW-class lasers.

4.2 Task 3b) Networking Activity on High energy Lasers (NAHEL)

Task leader: GSI-PHELIX

High energy lasers exceeding a kilojoule in pulse energy place very unique demands upon the optical components, operating procedures, staff training and safety precautions. Such high energy systems are presently operational in the Czech Republique (PALS), France (LULI and LIL), Germany (PHELIX), and Great Britain (Vulcan), and new facilities will be commissioned in the next few years (HILASE). Since large optics and opto-mechanical installations are involved, these new developments are typically costly and difficult. In addition, instrumentation, data-taking requirements and even theoretical approaches demand different approaches from those typical at the other facilities. Therefore a linkage between these laboratories is of particular use for their quality and scientific value.

One aim of this network is to promote an efficient exchange of information on subjects related to the operation of mid-scale high-energy laser facilities. Specific workshops on technical and organizational issues are organized at the different locations, which comprise practical campaigns where procedures are demonstrated "hands on" at the given facility to the experts from the other facilities. These workshops are also used for the exchange with non-European laboratories. Another important line of action is a common outreach initiative to foster emerging industrial and medical applications at these high-end facilities.

The NAHEL network very much continues the successful format defined during the Laserlab II period and facilitates very specific technical discussions in small groups, taking place at the network annual meetings which are foreseen to be organized in all the participating laboratories. In addition to the four initial network participants, other Laserlab partners and external experts are invited to discuss specific topics when needed. In 2012, the first meeting was held in Abingdon, UK, organized by RAL-CLF; in 2013, the second meeting was organized in Palaiseau, France by LULI/Ecole Polytechnique.

Among the recurring topics, issues related to the metrology of large-size lasers, storage and publication of machine parameters (database), control system and infrastructure requirements like radiation shielding are regularly covered. Information and reports on the progress of each group are usually given during the meetings so that synergies between laboratories can be found.

2012 annual meeting NAHEL, 11-13 June 2012, Abingdon, UK

The 2012 NAHEL workshop was hosted by the Central Laser Facility and held at the Cosener's House, Abingdon on the 11th & 12th June 2012. The introductory session was devoted to presentations by representatives of each of the attendee institutions (CLF, GSI, PALS and LULI) outlining the current status of the facilities and updates on development projects. This was followed by five discussion sessions covering a wide range of topics of importance for facility operations. Each session was presided over by a chair who had organized ahead of the meeting a series of questions to guide the discussion. During these sessions, PowerPoint slides were occasionally used as an aid to illustrate points, but no formal presentations were scheduled. The workshop concluded on the morning of 13th June with tours of the Central Laser Facility covering the Vulcan, Astra-Gemini, Artemis and Dipole laser systems and the Target Fabrication department.

The workshop was useful to highlight the operational issues common to all the facilities. Reliably diagnosing the laser properties delivered to target is a major challenge, in particular the measurement of the pulse duration and the focal spot. The amount of information provided to users varies across the facilities and automated post-processing of laser data is not generally performed. Plasma mirrors are in common use for contrast enhancement and thin pellicles are used for optic protection. High repetition rate operations are currently only of serious concern for the CLF (Gemini) but will affect upcoming facilities. The implications of moving to of order 1Hz operations in terms of mass production of targets and the necessary improvements in target positioning and data acquisition systems will have an impact on the cost of running facilities. The level of support provided by facilities for the users was also discussed. Planning of experiments begins 3 - 6 months before the start date with some facilities assigning a link scientist to co-ordinate the activity. The user training courses run by the CLF have been very successful and there is potential to extend this to a Laserlab-wide activity.

2013 annual meeting NAHEL, 4-5 November 2013, Palaiseau, France

The 2013 NAHEL workshop was organized by LULI and held in the Salle du Conseil, Institut Optique on 4-5 November. This meeting was organized in three parts: Two oral presentation sessions: the first one, on November the 4th, was devoted to the current status of the facilities and updates on development projects given by representatives of each of the working group members (LULI, CLF, GSI and PALS). The second one, on November the 5th, focused on the new and upcoming facilities (Orion, Salamanca and ELI). These two sessions were followed by five discussion sessions covering a wide range of technical topics, identified for improving facility operations. Each session was presided over by a chair who gave a kick-off talk introducing a series of questions to guide the discussion. The workshop concluded with tours of the LULI laser facilities (LULI2000, ELFIE, LUCIA project). The ELI beamlines together with PALS have agreed to host the next NAHEL workshop in 2014.

5 Task 4: Networking for Joint Research Activities

Task leader: POLIMI

Joint Research Activities foster many collaborations between infrastructures, which appear as a unique ground to stimulate further networking activities. The aim of this task is to organize and support networking exchanges in the context of the Joint Research Activities. One should note a crucial difference between the present networking task, related to JRAs, and the Joint Research Activities themselves: while JRAs encompass a well-defined sub-group of Laserlab-Europe, networking activities are by nature open to all Laserlab participants. Networking for Joint Research Activities is therefore an efficient means to induce a leverage effect on the knowledge and know-how created within the JRA consortia, and having it spread throughout the entire Laserlab-Europe community. Networking activities for Joint Research Activities include joint meetings of several or all JRA, in addition to the working meetings of the individual JRA, and actions dedicated to partners not directly supported within the individual JRA activities.

During the first reporting period, the individual JRAs have held several meetings, where associate partners from outside the project (e.g. IPHT, Institute of Photonic Technology, Jena, Germany, as associate partner in BIOPTICHAL, representing Photonics4life, the European Network of Excellence for Biophotonics) and partners from within Laserlab-Europe but not directly involved in the respective JRA have participated in order to create the largest possible impact for the scientific implementation of the JRA work. In addition, preparations have started for a joint JRA meeting, which will take place in Warsaw, Poland, on 31 March and 1 April 2014.